SB761
.A3A5
no. 81-4

Forest Insect And Disease Management

3430

BIOLOGICAL
EVALUATION R10-81-4

SPRUCE BEETLE

CHUGACH NATIONAL FOREST
ANCHORAGE RANGER DISTRICT

OCTOBER 1981

U.S. Department of Agriculture
State and Private Forestry

Forest Service
Alaska Region

3430

BIOLOGICAL EVALUATION R10-81-4

SPRUCE BEETLE

CHUGACH NATIONAL FOREST
ANCHORAGE RANGER DISTRICT

OCTOBER 1981

Prepared By: Edward H. Holsten

Edward H. Holsten, Entomologist
Forest Pest Management
Region 10, Alaska

Approved By: Robert D. Averill

Robert D. Averill, Group Leader
Forest Pest Management
State and Private Forestry
Region 10, Alaska

Wendell Doty

Wendell Doty, Director
State and Private Forestry
Region 10, Alaska

ROCKY MOUNTAIN RESEARCH STATION LIBRARY
FORT COLLINS CENTER
240 W PROSPECT RD
FORT COLLINS, CO 80526-2098

Forest Pest Management
State and Private Forestry
USDA Forest Service, R-10
2221 E. Northern Lights Blvd.
Suite 107
Anchorage, Alaska 99504

****

Caution: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife - if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers. Mention of a pesticide in this publication does not constitute a recommendation for use by the USDA, nor does it imply registration of a product under the Federal Insecticide, Fungicide, and Rodenticide Act, as ammended. Mention of a proprietary product does not constitute an endorsement by the USDA.

****

CONTENTS

page

INTRODUCTION..... 1

OBJECTIVE..... 1

MATERIALS AND METHODS..... 1
Study Sites..... 5
Stand Composition..... 5
Spruce Beetle Populations..... 5

RESULTS AND DISCUSSION..... 5
Silvertip Creek..... 5
Stand Composition..... 5
Spruce Beetle Population and Tree Mortality..... 7
Guard Station..... 7
Stand Composition..... 7
Spruce Beetle Population and Tree Mortality..... 8
Gulch Creek..... 8
Stand Composition..... 8
Spruce Beetle Population and Tree Mortality..... 8
Canyon Creek..... 8
Stand Composition..... 8
Spruce Beetle Population and Tree Mortality..... 9
Granite Creek Road..... 9
Stand Composition..... 9
Spruce Beetle Population and Tree Mortality..... 9
Granite Creek Campground..... 10
Stand Composition..... 10
Spruce Beetle Population and Tree Mortality..... 10

MANAGEMENT ALTERNATIVES..... 10

RECOMMENDATIONS..... 14

REFERENCES..... 15

APPENDICES..... 16
Appendix A--Stand Structure Summary..... 16
Appendix B--Spruce Beetle Populations and Tree Mortality Summary... 17
Appendix C--Impact Summary..... 18
Appendix D--Spruce Beetle Biology..... 19

INTRODUCTION

Alaskan spruce beetle (Dendroctonus rufipennis (Kby.))(App. D) populations are high throughout south-central Alaska; approximately 243,774 acres of infested white spruce (Picea glauca (Moench) Voss.) were aerially detected in 1981. White spruce mortality is occurring on 39,936 acres of the Chugach National Forest representing an increase of 7,736 acres (19 %) over 1980 levels (Fig. 1).

With respect to the Chugach National Forest, the Summit Lake infestation has intensified and extends over approximately 13,546 acres. The Resurrection Creek infestation has not expanded from the 1980 level of 14,826 acres. However, the number of killed trees and new attacks are still increasing, especially on the upper slopes of the drainage. To date, 7,093 board feet per acre of white spruce has been killed by the spruce beetle in five years representing 60 percent of the commercial spruce volume.

Forest Pest Management (F.P.M.) was requested in June 1981 by the Anchorage Ranger District (Chugach National Forest) to undertake a spruce beetle evaluation of the white spruce stands in the general vicinity of the Granite Creek Campground. Parts of this area, specifically Gulch Creek and Silvertip Creek, have on-going beetle infestations and have been previously documented (Holsten and Zogas, 1979, Holsten 1981).

OBJECTIVES

If spruce beetle outbreaks are allowed to run their natural cycles, significant changes in stocking levels and aesthetic qualities of the landscape can occur. Accordingly, the general objectives of this evaluation were:

(1) To determine the incidence of bark beetle activity in the immediate campground area.

(2) To evaluate the on-going infestations in the surrounding areas.

(3) To detect and evaluate any new infestations.

(4) To discuss and recommend various management alternatives with respect to the infestations.

MATERIALS AND METHODS

F.P.M. personel undertake yearly insect and disease aerial detection surveys of the forested areas throughout the State. In early August, the general area to be evaluated was aerially surveyed and all on-going beetle activity was mapped on 1:63,360 quadrangles (Fig. 2). Ground surveys were conducted in mid-August (1981) by F.P.M. personel in the following areas as determined by the aerial survey (Fig. 2):

Fig. 1. 1981 spruce beetle infestations on the Chugach National Forest; based on the U.S.G.S. Seward 1:250,000 Quadrangle

Legend: -1981 Spruce Beetle Infestations

\- - - - - Highways

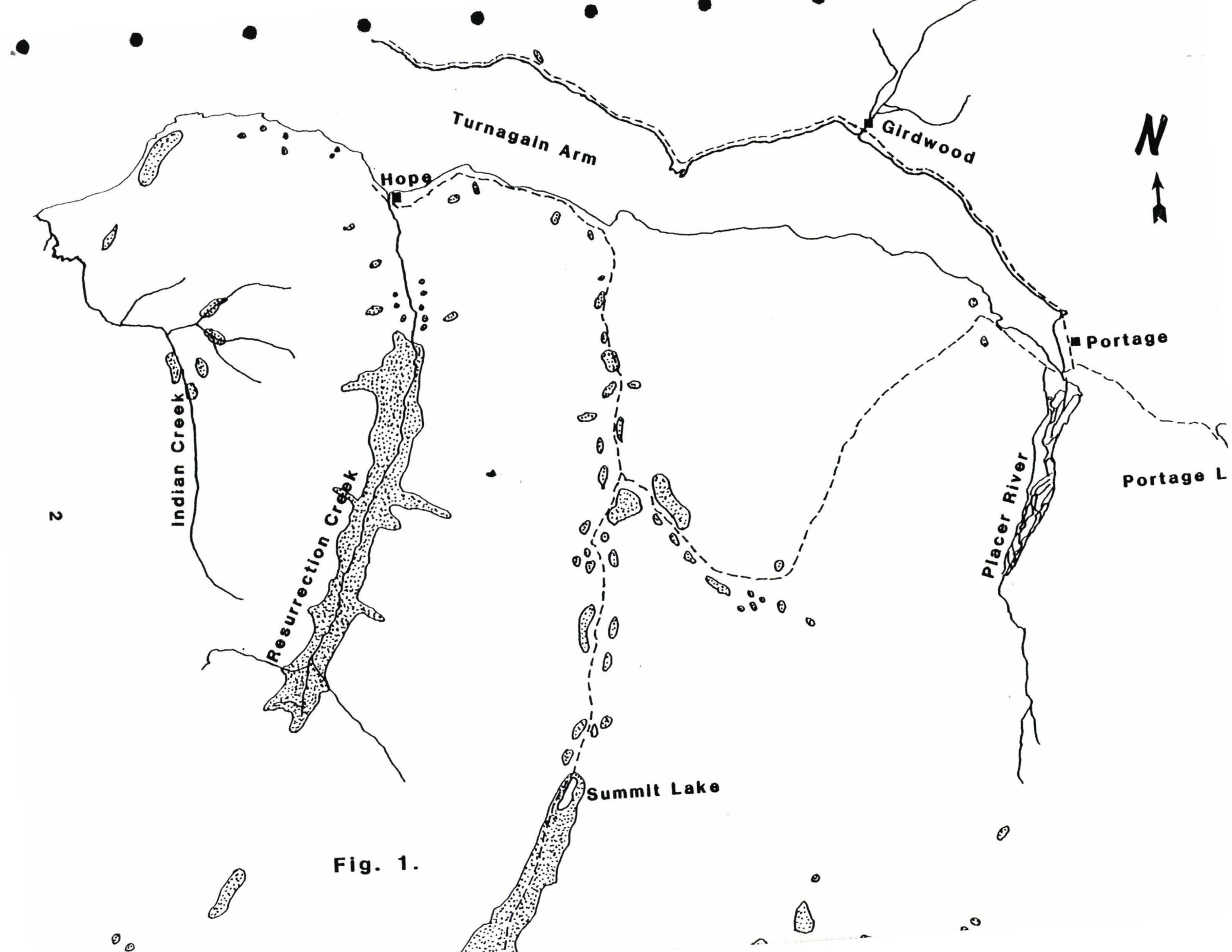
Turnagain Arm
Girdwood
N
Hope
Portage
Indian Creek
Resurrection Creek
Placer River
Portage L
Summit Lake

Fig. 1.

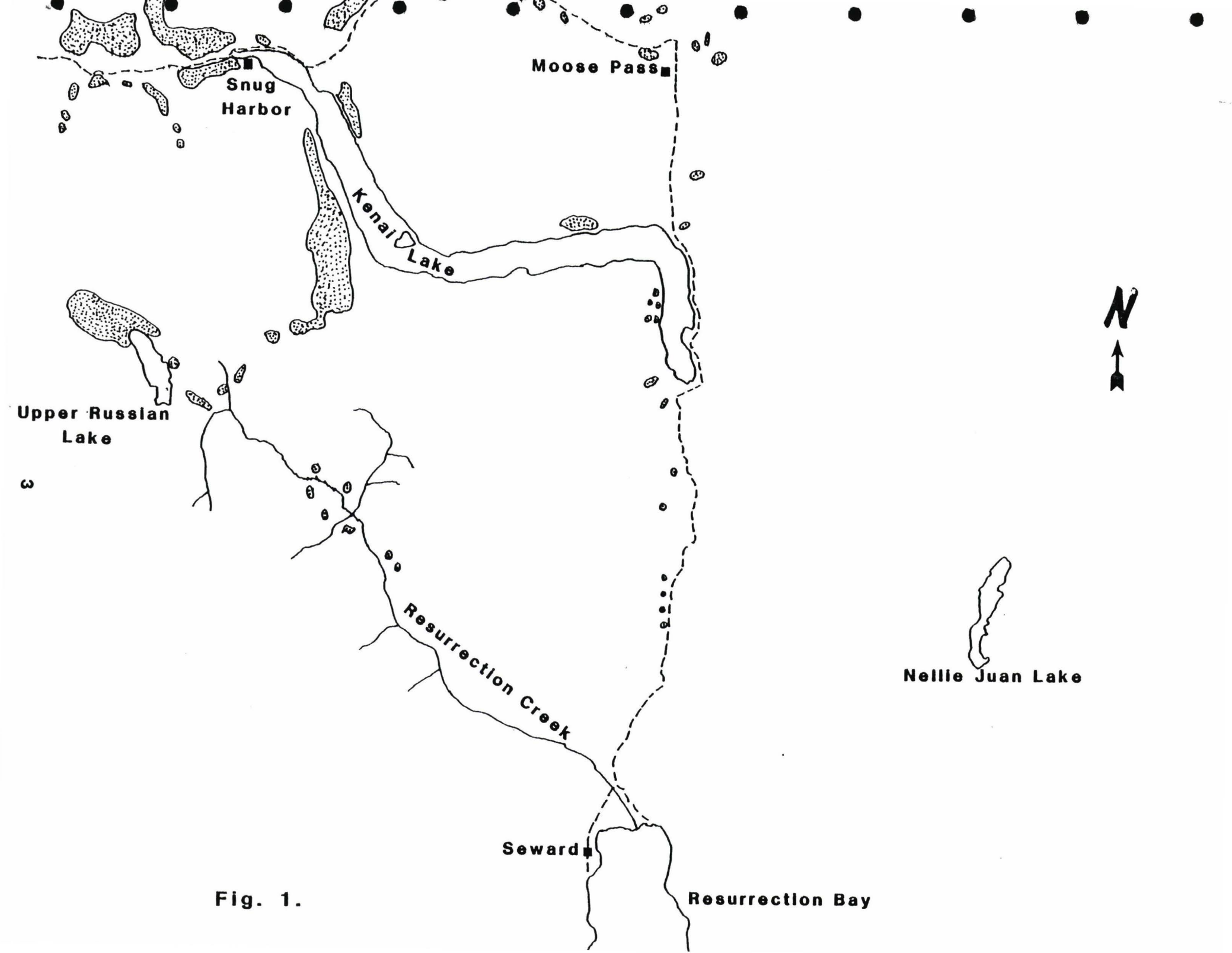
Moose Pass
Snug Harbor
Kenai Lake
N
Upper Russian Lake
Resurrection Creek
Nellie Juan Lake
Seward
Resurrection Bay

Fig. 1.

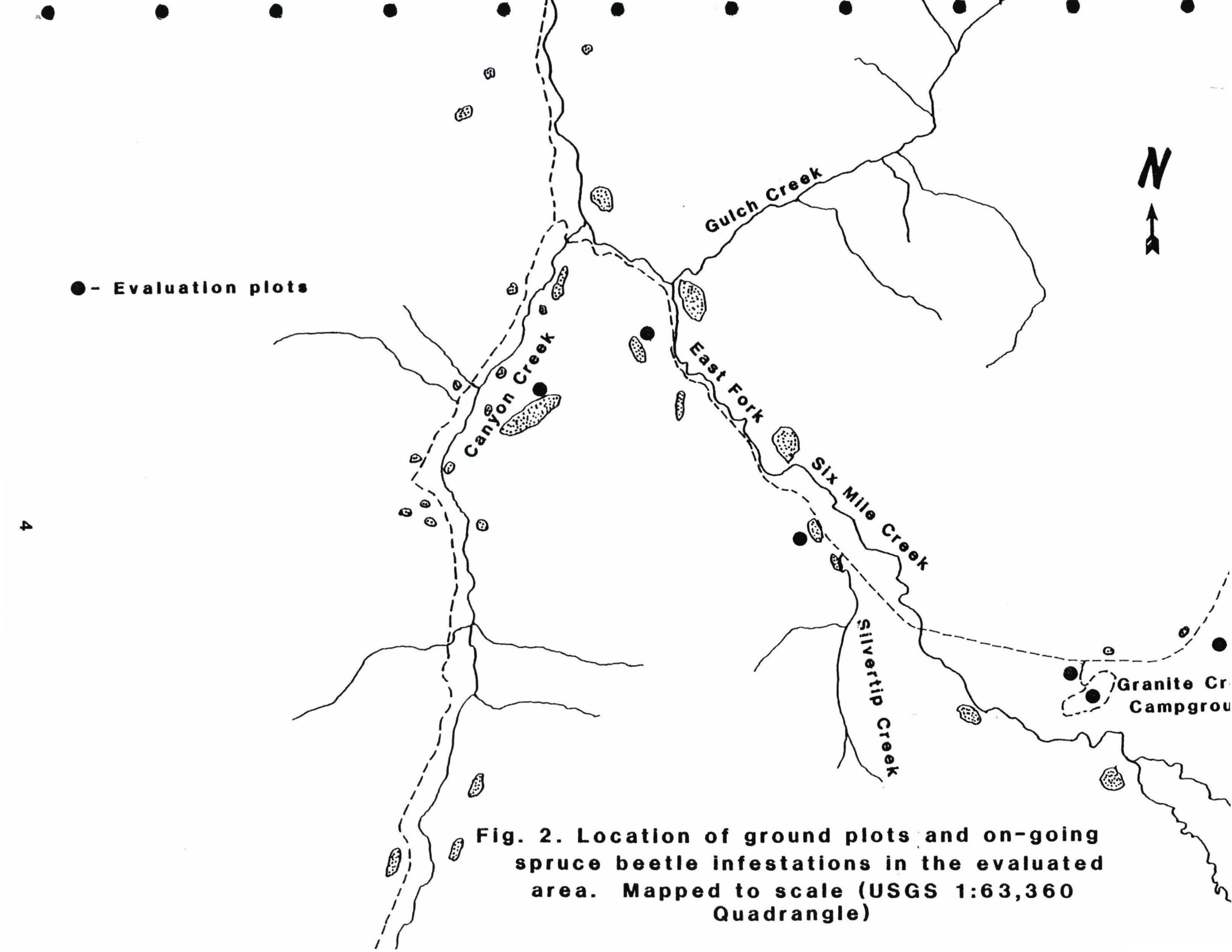

Fig. 2. Location of ground plots and on-going spruce beetle infestations in the evaluated area. Mapped to scale (USGS 1:63,360 Quadrangle)

STUDY SITES:

Silvertip Creek: An evaluation was carried out in this area last year (Holsten 1981). However, due to increasing beetle activity in this area an evaluation of spruce beetle population trends was undertaken.

Guard Station: Ten variable plots were established on the east side of the Seward Highway, approximately two miles northeast of the entrance to the Granite Creek Campground.

Dry Gulch Creek: Nine variable plots were established on the hillside directly across from the Gulch Creek infestation (Fig. 3).

Canyon Creek: Ten variable plots were established bordering the power-line on the east side of Canyon Creek (Fig. 4).

Granite Creek Road: Ten variable plots were established paralleling the road into the campground.

Granite Creek Campground: Eight variable plots were established in the area encircled by the campground road.

STAND COMPOSITION: Variable plots (BAF=10) were established in each area with the exception of Silvertip Creek; stand composition was previously documented by Holsten (1981). Plots were established at five chain intervals on lines five chains apart throughout the stand. A basal area 10-factor prism and a Spiegal Relaskop were used to determine plot trees and tree heights. All trees within each plot were recorded by species and diameter at breast height(d.b.h.). Radial growth and height were determined for two dominant or co-dominant spruce trees in each plot.

SPRUCE BEETLE POPULATIONS: When spruce beetle infestation centers were encountered, two 6x6 inch bark samples (north and south side) were removed from infested trees at d.b.h. Trees selected for sampling were attacked in the Spring of 1980. These trees contained new adults which will form the 1982 attacking population. The number of adults per bark sample was recorded along with the number and type of parasites and amount of woodpecker activity. Results were compared with Knight's (1960) sequential sampling plan for spruce beetles to give an indication of population trends.

RESULTS AND DISCUSSION[1/]

SILVERTIP CREEK:

Stand Composition: The plots were comprised of spruce (95%) with some scattered paper birch (3%)(*Betula papyrifera* Marsh) and western hemlock (2%)(*Tsuga heterophylla* (Raf.) Sarg.). Pockets of old blowdown occurred throughout the study site. Mean diameters of the species are: white spruce 13.4 ± 4.8 (n=101), birch 6.7 ± 1" (n=3) and, hemlock 5.7 ± 1.6" (n=2). Mean height and age for spruce are 63.1 ± 17.3" (n=41) and 139.8 ± 35.8 years (n=19), respectively.

[1/] See Appendices A,B, and C for Summary

Fig. 3. Gulch Creek Infestation

Fig. 4. Canyon Creek Infestation

Mean basal area for plots containing spruce is 101 ± 14.2 square feet per acre, ranging from 20 to 180 square feet. The mean outer inch of spruce radial growth is 34.3 ± 17.4 rings per inch; spruce diameter growth is averaging .06 inches per year in the last inch of growth. Mean volume for plots containing spruce is 7,452 b.f. per acre[2/].

Spruce Beetle Populations and Tree Mortality: Twenty four bark samples (92% infested) were removed and yielded a total of 125 adult beetles indicating a static to increasing population (Knight 1960). 1980 sampling of the same area indicated an increasing population. Mean adult density per sample was 5.2 ± 5.2 beetles; density ranged from 0 to 18 beetles per sample. Signs of woodpecker activity (bark beetle predators) were common and heavy on all sampled trees.

Mean diameters of recently attacked and old attacked (dead) white spruce are 15.7 ± 4.8" and 14.2 ± 4.7", respectively (not sign. diff.). Standing beetle killed timber and newly attacked spruce comprise 10 percent (719 b.f./ac.) and 17 percent (1,274 b.f./ac.), respectively. The majority of the newly attacked spruce will die. Seventy-three percent of the commercial white spruce is free of attack.

The 200 acre Silvertip infestation is from three to four years old. It is relatively young and increasing as mean diameters of recently attacked trees (15.7") are significantly higher than mean spruce diameters (13.4") in the evaluated area. Beetles immigrating from nearby infestations, such as Gulch Creek, probably initiated the Silvertip infestation.

Assuming that the newly attacked spruce will die, bark beetles have killed $7,972 worth of commercial spruce throughout the 200 acre infestation, using a $20/MBF stumpage value (App. C)[3/]. Since this infestation is increasing, we can expect at least $3,000 worth of spruce killed each year if the infestation is allowed to run its natural course.

GUARD STATION:

Stand Composition: The plots were located near the Granite Creek Guard Station on a west facing slope that has recent avalanche signs. The plots were comprised of spruce (68%) and western hemlock (32%). Pockets of old scattered blowdown occurred throughout the area. Mean diameters of spruce and hemlock are 13.3 ± 4.5" (n=60) and 7.2 ± 2.6" (n=22), respectively. Mean height and age for spruce are 66.8 ± 13' and 78 years.

Mean basal area for plots containing spruce is 62 square feet per acre. Average basal area is 91 square feet per acre. Spruce diameter growth is averaging .08 inches per year in the last inch of growth. Mean commercial spruce volume is 5,864 b.f. per acre.

2/Volume estimates were derived from:(1) R-10 Volume Tables for Alaska White Spruce, For. Serv. Hndbk. 2425, Jan. 1967 in conjunction with (2) Table 1(Stand Factors)from "Log Scaling and Timber Cruising", 1966. J.R. Dilworth. O.S.U. Bookstore. pg. 263.

3/Bob Green. Dec. 1980. Silviculturist. Chugach Nat'l. Forest. Personal Communication, Anchorage, Ak.

Spruce Beetle Populations and Tree Mortality: No recent (2 yrs. or less) spruce beetle attacks were encountered. Only three old attacked dead spruce were found. The diameters of these trees averaged 12.8 ± 3.1". The diameters of the uninfested live spruce averages 13.4 ± 4.6". Standing beetle killed timber comprise 19 percent (203.8 b.f./acre) of the commercial spruce. Assuming a $20/MBF stumpage value, actual loss attributed to bark beetles has averaged only $4.08 per acre (App. C).

The Guard Station area was evaluated due to its designation as a medium to high risk area (Holsten and Wolfe 1979). As previously mentioned, there are no new attacks nor is there any new blowdown which could trigger-off an infestation. It is felt that this area will remain relatively free of bark beetle problems for several years.

GULCH CREEK:

Stand Composition: These nine plots were comprised of spruce (92%) and paper birch (8%). Pockets of old blowdown occur throughout the site. Mean diameters of the spruce and birch are 11.3 ± 3.4" (n=93) and 9.2 ± 3.9" (N=8), respectively. Mean height and age for the spruce are 73.5 ± 13.9' and 108.5 years.

Mean spruce basal area is 101.2 ± 7.9 square feet per acre (total b.a.= 110 ± sq.ft./ac.). The mean outer inch of spruce radial growth is 25.6 ± 6.4 rings per inch; spruce diameter growth is averaging .08 inches per year in the last inch of growth. Mean commercial spruce volume is 8,893.5 b.f. per acre.

Spruce Beetle Populations and Tree Mortality: Twenty-four bark samples (83% infested) were removed and yielded a total of 103 adult beetles indicating a static to increasing population (Knight 1960). Mean adult density per sample was 4.3 ± 4.2 beetles.

Mean diameters of recently attacked and old attacked (dead) white spruce are 13.1 ± 2.5" and 13.5 ± 2.6", respectively (not sign. diff.). However, the average diameter of the uninfested spruce (10 ± 4.1") is significantly less (Students "t", P.05) than the recently attacked spruce. Standing beetle killed timber and newly attacked spruce comprise 38 percent (3,414 b.f./ac.) and 12 percent (1,024 b.f./ac.), respectively of the commercial spruce volume. Assuming that the newly attacked spruce will die, bark beetles have killed $2,653 worth of commercial spruce throughout the 30 acre infestation (App. C). Since this infestation is increasing, we can expect at least $1,000 worth of spruce killed each year if the infestation is allowed to run its natural course.

The Gulch Creek infestation is at least two years old as mean diameters of recently attacked spruce are significantly higher than the uninfesteed residual spruce. However, the infestation should not last much longer as the mean diameter of the uninfested spruce is relatively small (10"). Spruce beetle brood production and development decreases when the diameter of attacked trees approaches 8 inches.

CANYON CREEK:

Stand Composition: The Canyon Creek area is comprised of spruce (54%), western hemlock (44%) and birch (2%). A transmission line right-of-way runs

through the evaluated area. Mean diameters of the species are: white spruce 13.8 ± 5.3" (n=84), hemlock 10.7 ± 3.8" (n=70), and birch 6.1 ± 2.5" (n=3). Mean height and age for the spruce are 58.3 ± 14.9 feet and 130.6 years.

Mean basal area for spruce is 84.8 ± 16.3 square feet per acre with a total average basal area of 157 ± 30.2 square feet per acre. The mean outer inch of spruce radial growth is 30.8 ± 9 rings per inch; spruce diameter growth is averaging .06 inches per year in the last inch of growth.

Spruce Beetle Populations and Tree Mortality: Twently bark samples (100% infested) yielded a total of 213 adult beetles indicating an increasing population trend (Knight 1960). Mean adult density per sample was 13.3 beetles. Woodpecker activity was moderate on the infested trees.

Mean diameters of recently attacked, old attacked-dead, and uninfested spruce are 14.2 ± 4.7", 15.7 ± 6", and 12.3 ± 4.6", respectively (not sign. diff.). Standing beetle killed timber and newly attacked spruce comprise 33 percent (2,261 b.f./ac.) and 17 percent (1,214 b.f./ac.), respectively, of the average commercial white spruce volume (6,953.6 b.f./ac.). The majority of the newly attacked spruce will die. Fifty percent of the commercial white spruce is free of attack.

Assuming that the newly attacked spruce will die, bark beetles have killed $6,950 worth of timber throughout the 100 acre infestation (App. C). We can expect at least $2,428 worth of spruce killed each year if the increasing infestation is allowed to run its natural course.

This infestation is at least three to four years old. Although population trends are increasing, diameters of newly attacked spruce have decreased over previous kills. The beetles have depleted the most susceptible, larger diameter trees and are now forced to attack and breed in smaller trees. When the average diameter of the uninfested spruce approaches 8-10", the population will subside.

GRANITE CREEK ROAD:

Stand Composition: The area evaluated, along the entrance road to the campground, is comprised of spruce (78%) and black cottonwood (22%)(Populus trichocarpa Torr.&Gray). This area is characteristically open grown with abundant spruce regeneration. Mean diameters of the spruce and cottownwood are 10.3 ± 3.4" (n=106) and 17.7 ± 6.3" (n=30), respectively. Mean height and age for the spruce are 47' (n=10) and 102 years.

Mean spruce basal area is 106.9 ± 13 square feet per acre with the total species basal area averaging 137 ± 16.7 sq. feet per acre. The mean outer inch of spruce radial growth is 32.9 ± 8.9 rings per inch; spruce diameter growth is .06 inches per year in the last inch of growth.

Spruce Beetle Populations and Tree Mortality: Very little current beetle activity is present in the area. Consequently, a sequential sample could not be undertaken. Commercial spruce volume averages 4,134 b.f. per acre of which 3 percent (121.3 b.f./ac.) is comprised of old, standing beetle killed trees. This loss amounts to only $2.43 per acre (App. C).

Bark beetles are playing a minor role in this area and will continue to do so as the average spruce diameter is relatively low (10.3") and the spruce

are widely spaced and appear thrifty. Such a stand is not a high-risk for potential beetle problems (Holsten and Wolfe 1979).

GRANITE CREEK CAMPGROUND:

Stand Composition: The variable plots were established within the area bordered by the campground road. The plots were 100 percent spruce having a mean diameter of 9.1 ± 3.5" (n=58). Mean height and age for the spruce are 40' and 102 years. There is one patch of old blowdown located within the evaluated area.

Mean spruce basal area averages 72.5 ± 11.3 square feet per acre. The mean outer inch of spruce radial growth is 32.9 ± 8.9 rings per inch; spruce diameter growth is averaging .06 inches per year in the last inch of growth.

Spruce Beetle Populations and Tree Mortality: Very little on-going beetle activity was noted in the evaluated area. Consequently, a sequential sample of beetle populations was not possible.

Commercial spruce volume averages only 1,395 b.f. per acre of which 253 b.f. per acre (18%) is standing, old (dead) beetle killed trees and 66.8 b.f. per acre is recent beetle kill. This kill is worth an average of $6.40 per acre (App. C).

Similar to the campground road, bark beetles are a minor problem in the campground. The majority of the spruce is small (9") which is relatively resistant to bark beetle attack. Likewise, it appears that any beetle killed trees are quickly utilized by campers for firewood.

In general, the "real loss" due to bark beetles may not be stumpage, but reduced or altered recreation values. Although tangent values for recreation are difficult to determine, we can assume that the "recreation loss" in dollars is higher than the stumpage loss since these areas were selected for campgrounds and other recreation uses vs. timber production. Even though bark beetle populations will decline, resulting in decreasing stumpage losses, the "loss" in recreation will remain constant as the "damage" has been done.

MANAGEMENT ALTERNATIVES

MAINTAIN PRESENT MANAGEMENT--The spruce beetle infestations would be allowed to run their course under this approach. The beetle would dictate management outputs from the infested areas and would tend to constrain the management directions that could be taken in these areas (Averill 1978). If left alone, spruce beetle infestations would collapse from a combination of:(1)lack of large diameter trees to maintain brood production; (2)unfavorable weather conditions, especially during adult Spring dispersal; and (3)heavy predation and parasitism. However, adverse as well as beneficial effects of the outbreak would have to be accepted, such as:

(1)Changes in the forest plant composition could occur as a result of the opening of the forest canopy. Such changes may result in reduced spruce regeneration if no site disturbances occur. Reforestation may be necessary. However, some of the plant composition changes may be beneficial to some wildlife.

(2)Following spruce beetle infestations, fire risk may increase. There will be an increase in rate of spread, ignition probability and burning index.

(3)Visual qualities and social impacts would result if this alternative was selected (Averill et. al 1977). The ratio of green spruce to "red topped" spruce to gray snags will increase toward the snag end of the scale if spruce beetle populations continue to increase. The introduction of color or variety may be unacceptable due to the psychological impact of introducing dying plant materials (Averill et. al 1977). In addition, the dead trees may constitute a safety hazard to visitors using the areas.

(4)There will be no direct costs associated with selection of this alternative although as previously mentioned, timber values will be affected and revenues reduced when severely damaged stands are harvested. Likewise, this alternative would not be effective in preventing additional tree mortality.

Table 1 displays the potential loss of these infestation centers. Assuming that the volume was available to the market at $20 MBF, the present value of the anticipated loss is $37,759.85. All lands evaluated are not designated exclusively for commercial timber production but are managed for their recreational and wildlife values. One must assume that the total value of these lands is greater than what is being lost now. Management must ask themselves what outputs are or will be threatened by large spruce beetle outbreaks in the Cook Inlet area. Where loss levels exceed management goals then action must be taken to prevent the loss. Management needs to be very much aware of the potential adverse public reaction to excessive tree mortality. As more visitors and residents become aware of the spruce beetle and what is happening, one may anticipate a demand to control or at least manage the beetle populations at an acceptable level.

CHEMICAL SUPPRESSION--The use of registered pesticides for spruce beetle prevention and suppression is a viable alternative in certain situations:

(1)On a large scale, use of pesticides is not economically practical as applications must be done on the ground to every infested tree.

(2)However, in recreation areas and campgrounds where tree mortality would be unacceptable and hazardous to visitors, individual high value trees could be treated with an EPA-registered insecticide. Application costs would have to be accepted. Adverse environmental effects would be minimal and temporary.

A registered insecticide for use against the spruce beetle is Lindane^{R}.

TRAP TREES--This alternative involves the falling of green uninfested trees to serve as an attractant to flying adults. Removal and treatment of the infested trees would occur after flight is complete.

Effects of this treatment are:

(1)This method has been used on the Chugach National Forest with success and is a viable alternative.

TABLE 1. Potential Loss (B.F./Infestation)[1/]

	BEETLE POPULATIONS[2/] Inc.	Static	Dec.	1981	1982	1983	1984	1985	1986
Silvertip Creek	X	X	---	254,800	254,800	254,800	254,800	0	0
Guard Station	---	3/	---	0	0	0	0	0	0
Gulch Creek	X	X	---	30,720	30,720	30,720	30,720	0	0
Canyon Cr.	X	---	---	121,400	121,400	121,400	121,400	121,400	121,400
Granite Cr Road	3/	---	---	0	0	0	0	0	0
Granite Cr Campground	3/	---	---	0	0	0	0	0	0
Total B.F.				406,920	406,920	406,920	406,920	121,400	121,400
Stumpage ($20/MBF)				$8,138.40	$8,138.40	$8,138.40	$8,138.40	$2,428.00	$2,428.00
4% inc. Stumpage				$8,138.40	$8,464.02	$8,802.58	$9,154.68	$2,840.00	$2,954.03
NPV[4/] of Pot. Loss				$33,759.85					

1/ Volume lost in timber killed prior to 1981 is not included.
2/ Assuming increasing, static, and decreasing populations will continue for 5, 3, and 2 years, respectively.
3/ Insufficient data.
4/ Net Present Value using a 10% Discount Rate.

(2)Trees must be felled before beetle flight. Removal of infested felled trees is necessary within one year of infestation. If they are not removed, beetle populations may dramatically increase in the already infested area.

SALVAGE LOGGING--Logging of infested material would remove the material to another location where the brood could be destroyed.

Effects of this alternative are:

(1)The lumber from the infested trees could be utilized (e.g. firewood for campgrounds).

(2)However, the removal of the infested trees may only be a temporary solution. Stand composition would not be altered to any degree through salvage logging alone. Thus, risk of future infestations will remain high.

FELLING AND BURNING OF THE INFESTED TREES--Falling and burning infested trees will destroy bark beetle brood.

Effects of this alternative are:

(1)This should be done in Winter to reduce the fire hazard and kill the beetles before Spring emergence.

(2)Lumber from the infested trees is not utilized.

(3)This alternative may not prevent future infestations occurring in the treated area.

SILVICULTURAL MANAGEMENT--Silvicultural treatments in white spruce stands should be designed to create stand conditions that minimize tree mortality. Thinning of the residual stand and removal of the currently infested trees eliminates the immediate threat, as well as possibly creating a "beetle proof" stand for the next 20 or more years. This method appears to work with other Dendroctonus beetles and should work with spruce beetles (Averill 1978).

Effects of this alternative are:

(1)Conversion of spruce stands to a less susceptible state could be costly; however, long term benefits could be achieved. A sale for the removal of infested material as well as thinning could be let, thereby lowering the cost of this alternative.

(2)Thinning of overstocked groups of trees to basal areas of 80-90 square feet per acre improves tree growth in terms of diameter, volume and height through reduced competition. Stands with healthy, vigorous-growing trees are more resistent to losses by the spruce beetle than slow-growing or stagnant stands.

(3)This alternative would maximize investment returns since other management alternatives do not treat the mid-range (5-20 yr.) risk (Averill 1978).

(4)Application of sound silvicultural treatments would enhance other management objectives identified by the Forest.

RECOMMENDATIONS

Forest Pest Management would like to see the continuation of silvicultural manipulations in the Summit Lake area to show that regulating stand density not only minimizes spruce beetle threat, but can be used to enhance a multiple of management objectives in high valued roadside areas.

Potential losses from the spruce beetle can be minimized through an accelerated program of: (1)logging or burning of infested trees. A possible area for salvage logging is the Canyon Creek area. There already exist roads into the infested area which should minimize the cost of logging; and (2)silvicultural treatments. This treatment should be directed to those stands rated medium and high risk as to susceptibility of beetle attack (Holsten and Wolfe 1979, Holsten 1979). Recurring epidemics can be expected on the Kenai Peninsula until average tree diameter of the stands is reduced to approximately 8-10" and basal area reduced to approximately 80 square feet per acre.

High valued recreation and administrative sites, such as Granite Creek Campground, could be treated with the protective chemical Lindane^{R} to prevent spruce beetle attack. This should be carried out until the surrounding epidemics subside. Likewise, the campground area should be cruised on a yearly basis. All newly attacked trees should be removed. The wood could be utilized as firewood for the campground.

REFERENCES

Averill, R.D., Gunter, J.E., Lister,C.K., and D.H. Sonnen. 1977. Guidelines for Estimating the Economic Benefits of Mountain Pine Beetle Control Projects. Tech. Rpt. R-2-11, For. Ins. and Dis. Mgt., USDA For. Serv., Rocky Mtn. Region. 30p.

_____. 1978. Spruce Beetle--Summit Lake. Biol. Eval. R-10-78-3. For. Ins. and Dis. Mgt., State and Private Forestry, USDA For. Serv., Alaska Region. 8p.

Holsten, E.H., and R.L. Wolfe. 1979. Spruce Beetle Risk Rating System for White Spruce on the Kenai Peninsula. Tech. Rpt. R-10-1, For. Ins. and Dis. Mgt., State and Private Forestry, USDA For. Serv., Alaska Region. 21p.

_____. 1979. Supplement: Spruce Beetle Risk Rating for White Spruce on the Kenai Peninsula, Tech. Rpt. R-10-3, For. Ins. and Dis. Mgt., State and Private Forestry, USDA For. Serv., Alaska Region. 10p.

_____, and K.P. Zogas. 1979. Spruce Beetle--Summit Lake, Dry Gulch, Cooper Landing. Biol. Eval. R-10-79-4, For. Ins. and Dis. Mgt., State and Private Forestry, USDA For. Serv., Alaska Region. 18p.

_____, 1981. Spruce Beetle: Chugach National Forest and Adjacent Lands. Biol. Evalua. R10-81-1, For. Pest Mgt., State and Private Forestry, USDA For. Serv., Alaska Region. 18pp.

Knight, F.B. 1960. Sequential sampling of Englemann spruce beetle infestations in standing trees. USDA For. Serv., Rocky Mountain For. and Range Exp. Stat., Res. Note 47. 4p.

APPENDIX A

STAND STRUCTURE

	STAND COMPOSITION(%) SPRUCE	BIRCH COTT.	HEMLOCK	SPRUCE DBH(in.)	SPRUCE HT(ft.)	SPRUCE AGE(yr)	AV.DIA. GROWTH (in./yr.)	SPRUCE B.A. sqft/ac	SPRUCE VOLUME b.f./ac
Silvertip Creek	95	3	2	13.4	63	140	.06	101	7,452
Guard Station	68	--	32	13.3	67	78	.08	62	8,864
Gulch Creek	92	8	--	11.3	73.5	109	.08	101	8,894
Canyon Cr.	54	2	44	13.8	58	131	.06	85	6,954
Granite Cr Road	78	22	--	10.3	47	102	.06	107	4,134
Granite Cr Campground	100	--	--	9.1	39	102	.06	73	1,395

APPENDIX B

SPRUCE BEETLE POPULATION AND TREE MORTALITY

	Beetle Population			AV. D.B.H. new attacks (in.)	AV. D.B.H. old attacks (in.)	AV. D.B.H. uninf. spruce (in.)	Vol. Lost in beetle kill(/ac.)A	Vol. in new attacks (/ac)B	Total Poss. volume loss (/ac.)A + B
	Incr.	Static	Decr.						
Silvertip Creek	X	X	---	15.7	14.2	--	719(10%)	1,274(17%)	1,933(27%)
Guard Station	---	1/	---	----	12.8	13.4	204(19%)	----------	204(19%)
Gulch Creek	X	X	---	13.1*	13.5	10*	3,414(38%)	1,024(12%)	4,434(50%)
Canyon Cr.	X	---	---	14.2	15.7	12.3	2,261(33%)	1,214(17%)	3,475(50%)
Granite Cr Road	1/	---	---	----	----	10.3	121(3%)	----------	121(3%)
Granite Cr Campground	1/	---	---	12.0	13.4	8.6	253(18%)	67(5%)	320(23%)

* sign. differance, Students "T", .05

1/ insufficient data

APPENDIX C

IMPACT

	Acres Infest.	Actual loss1/ ($) per ac.(A)	Actual loss ($) (B)	Potential loss2/ ($) per ac.(C)	Potential loss ($) (D)	Total loss ($) per ac.(A+C)	Total loss ($) (B+D)
Silvertip Creek	200	14.38	2,876	25.48	5,096	39.86	7,972
Guard Station	---	4.08	-------	-----	-------	4.08	-------
Gulch Creek	30	68.30	2,048	20.48	614	88.78	2,663
Canyon Cr.	100	45.22	4,522	24.28	2,428	69.50	6,950
Granite Cr Road	---	2.43	------	-----	------	2.43	------
Granite Cr Campground	---	5.06	------	1.34	------	6.40	------

1/ Actual loss = standing, dead beetle killed spruce
2/ Potential loss = currently infested spruce; the majority of these will die

APPENDIX D

SPRUCE BEETLE

COLEOPTERA:SCOLYTIDAE

Dendroctonus rufipennis (Kby.)

HOST--White, Sitka, and rarely black spruce

DAMAGE--Larvae feed under tree bark which may result in tree death

DISTRIBUTION--Throughout Alaska where host is located. A serious forest pest especially in south-central Alaska.

DESCRIPTION--Adult spruce beetles are dark brown to black, cylindrical in shape, approximately 5mm long and 3mm wide. The larvae are stout, white, legless grubs, 6mm long at maturity. The pupae are white, soft-bodied, and adult shaped.

BIOLOGY--The life cycle of the spruce beetle in Alaska is not definitely known, but is believed to be two years in duration. Adult and larval activity begins in May when under the bark daytime temperatures reach about 8°C(47°F). Recently emerged adult beetles disperse in search of susceptible host material during late May and early June when daytime ambient temperatures are at least 16°C(61°F). Dispersing adults adults can fly long distances, over seven miles nonstop. Adult mortality during dispersal may exceed 50 percent. Females are attracted to windthrow and other large diameter (8" or more) down material and begin the attack; males arrive later.

Beetles prefer to begin attack on the sides and bottoms of downed material. Under such conditions, temperature and moisture regimes are favorable for brood development and survival. Unpublished data indicate that windthrown trees can remain attractive through two attack periods. Males and other females are attracted via sex and aggregating pheromones. *D. rufipennis* is monogamous, and females deposit eggs in niches along the sides of the vertical egg gallery in a standing tree. Egg galleries, except for the terminal portion, are packed with frass and boring material. Most eggs hatch by August.

Larvae predominate during the first overwintering period, although other life stages may be present. Most of the larvae pupate in the following summer; the pupal period last 10-15 days. The adults may overwinter in their pupal sites or migrate to the base of infested trees. This migration is an adjustment to cold temperature survival. The following spring (approximately two years after attack) adults emerge and attack new host material. In general, females only attack once.

Most *D. rufipennis* outbreaks in standing timber have originated in blowdowns although logging residuals (cull logs) may be a contributing factor. In the Rocky Mountains and probably Alaska, the susceptibility of standing spruce decreases in the following order: (1)Large diameter trees along creek bottoms, (2)Better stands on benches, (3)Poorer stands on ridges and benches, (4)Mixtures of spruce and other species, and (5)Stands of immature trees.

In the lower 48 states, parasites and predators help reduce and maintain spruce beetle populations at low levels. However, the effect of predation and parasitism on spruce beetle populations in Alaska is not known. In the Rocky Mountains, Northern 3-toed, hairy, and downy woodpeckers can consume 40-98 percent of beetle brood during outbreak conditions. These predators are common in Alaska in beetle infested areas and probably contribute to the decline of epidemic insect populations. Low temperatures are effective controls if the cold spells occur early before the insects become cold hardy.